CLAIMS

1. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples of a prescribed shape are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine humps, fine holes or fine unevenness of a prescribed shape are formed at the rims of said dimples and/or on the indented surfaces of said dimples.

2. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine humps 1 to 50 μm in height and 5 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

3. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine holes 5 μm or more in depth and 5 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

4. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine unevenness 1 to 50 μm in average depth and 10 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

5. A cooling drum for metal cast strip by

continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine humps 1 to 50 μm in height and 30 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples adjacent to each other.

6. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; fine humps 1 to 50 μm in height and 30 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples adjacent to each other; and also fine humps 1 to 50 μm in height and 5 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

7. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; fine humps 1 to 50 μm in height and 30 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples adjacent to each other; and fine holes 5 μm or more in depth and 5 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

8. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of

said dimples; fine humps 1 to 50 μm in height and 30 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples adjacent to each other; and fine unevenness 1 to 50 μm in average depth and 10 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

9. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine holes 5 μm or more in depth and 5 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples.

10. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; fine holes 5 μm or more in depth and 5 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples; and fine humps 1 to 50 μm in height and 5 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

11. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine holes 5 μm or more in depth and 5 to 200 μm in diameter of circle equivalent are formed at the rims and on the indented surfaces of said dimples.

12. A cooling drum for metal cast strip by

continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; fine holes 5 μm or more in depth and 5 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples; and fine unevenness 1 to 50 μm in average depth and 10 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples.

13. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples of a prescribed shape are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine unevenness and fine humps are formed at the rims of said dimples and/or on the indented surfaces of said dimples.

14. A cooling drum for metal cast strip by continuous casting according to claim 13, characterized in that said dimples of a prescribed shape are 40 to 200 μm in average depth and 1.0 to 4.0 mm in average diameter of circle equivalent.

15. A cooling drum for metal cast strip by continuous casting according to claim 13 or 14, characterized in that the average depth of said fine unevenness is 1 to 50 μm and the height of said fine humps is 1 to 50 μm; and also the height of said fine humps is smaller than the average depth of said fine unevenness.

16. A cooling drum for metal cast strip by continuous casting according to any one of claims 13 to 15, characterized in that: said fine unevenness are formed by spraying alumina grit; and said fine humps are formed by the intrusion of the fragments of the alumina grit.

17. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 1.0 to 4.0 mm in average diameter and 40 to 200 μm in average depth are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine unevenness 10 to 50 μm in average diameter and 1 to 50 μm in average depth and fine humps 1 to 50 μm in height formed by the intrusion of the fragments of the alumina grit are formed at the rims of said dimples and/or on the indented surfaces of said dimples.

18. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples of a prescribed shape are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and the region where the dimples 20 μm or less in average depth exist consecutively at a distance of 1 mm or more accounts for 3 % or less.

19. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 1.0 to 4.0 mm in average diameter and 40 to 170 μm in average depth are formed on the peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and the region where the dimples 20 μm or less in average depth exist consecutively at a distance of 1 mm or more accounts for 3 % or less.

20. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the plated peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and a film, containing a substance more excellent than Ni in wettability with scum, is formed on said peripheral surface.

21. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to

200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the plated peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; fine humps 1 to 50 μm in height and 5 to 200 μm in diameter of circle equivalent are formed on the indented surfaces of said dimples; and a film, containing a substance more excellent than Ni in wettability with scum, is formed on said peripheral surface.

22. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the plated peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; and fine humps 1 to 50 μm in height and 30 to 200 μm in diameter of circle equivalent, where a film, containing a substance more excellent than Ni in wettability with scum, is formed, are formed at the rims of said dimples adjacent to each other.

23. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the plated peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; fine humps 1 to 50 μm in height and 30 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples adjacent to each other; and also fine humps 1 to 50 μm in height and 5 to 200 μm in diameter of circle equivalent, where a film, containing a substance more excellent than Ni in wettability with scum, is formed, are formed on the indented surfaces of said dimples.

24. A cooling drum for metal cast strip by continuous casting, characterized in that: dimples 40 to

200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent are formed on the plated peripheral surface of the cooling drum, adjacent to each other at the rims of said dimples; fine holes 5 μm or more in depth and 5 to 200 μm in diameter of circle equivalent are formed at the rims of said dimples; and also fine humps 1 to 50 μm in height and 5 to 200 μm in diameter of circle equivalent, where a film, containing a substance more excellent than Ni in wettability with scum, is formed, are formed on the indented surfaces of said dimples.

25. A cooling drum for metal cast strip by continuous casting according to any one of claims 20 to 24, characterized in that said substances more excellent than Ni in wettability with scum are oxides of the elements composing the molten steel which is continuously cast.

26. A cooling drum for metal cast strip by continuous casting according to any one of claims 20 to 24, characterized in that said substances more excellent than Ni in wettability with scum are oxides of the elements composing the plated layer on the peripheral surface of the cooling drum.

27. A cooling drum for metal cast strip by continuous casting according to claim 20 or 21, characterized in that said film containing a substance more excellent than Ni in wettability with scum is a film formed by the oxidation of the plated layer on the peripheral surface of the cooling drum.

28. A cooling drum for metal cast strip by continuous casting according to claim 20 or 21, characterized in that said film containing a substance more excellent than Ni in wettability with scum is a film formed by the deposition of oxides generated by the oxidation of component elements in molten steel on the plated layer on the peripheral surface of the cooling

drum.

29. A cooling drum for metal cast strip by continuous casting according to any one of claims 20 to 24, 27 and 28, characterized in that said plated layer contains an element or elements more susceptible to oxidation than Ni.

30. A cooling drum for metal cast strip by continuous casting according to any one of claims 20 to 24, 27 and 29, characterized in that said plated layer contains one or more of W, Co, Fe and Cr.

31. A cooling drum for metal cast strip by continuous casting, characterized in that: the thermal conductivity of the base material of the drum is not less than 100 W/m·K; an intermediate layer 100 to 2,000 μm in thickness having the coefficient of thermal expansion of 0.50 to 1.20 times that of said drum base material and Vickers hardness Hv of not less than 150 is coated on the surface of said drum base material; a hard plated layer 1 to 500 μm in thickness having Vickers hardness Hv of not less than 200 is applied on the outermost surface; further on the surface, dimples 200 to 2,000 μm in diameter and 80 to 200 μm in depth are formed so as to contact each other or adjacent to each other; and fine holes 50 to 200 μm in diameter and 30 μm or more in depth are formed so as to have the pitch of 100 to 500 μm but not to contact each other.

32. A cooling drum for metal cast strip by continuous casting according to claim 31, characterized in that: said drum base material is copper or copper alloy; said intermediate layer is a plated layer consisting of Ni, Ni-Co, Ni-Co-W or Ni-Fe; and said hard plated layer on the outermost surface consists of any one of Ni-Co-W, Ni-W, Ni-Co, Co, Ni-Fe, Ni-Al and Cr.

33. A cooling drum for metal cast strip by continuous casting according to claim 31 or 32,

characterized in that: said dimples are formed by shot blasting; and said fine holes are formed by pulsed laser material processing.

34. A method of processing a cooling drum for metal cast strip by continuous casting by processing the peripheral surface of the cooling drum used for continuously casting a thin slab, characterized in that: when fine holes 50 to 200 μm in diameter and not less than 50 μm in depth are formed so as to have the pitch of 100 to 500 μm but not to contact each other by irradiating Q-switched CO_2 laser light to the surface layer of the cooling drum, the pulse energy of Q-switched CO_2 laser light is 40 to 150 mJ, total time span is 30 to 50 μsec and the condensed diameter of the laser beam is 50 to 150 μm.

35. A method of processing a cooling drum for metal cast strip by continuous casting according to claim 34, characterized by forming dimples 200 to 3,000 μm in diameter and 80 to 250 μm in depth on the surface layer of said drum so as to contact each other or adjacent to each other before said laser light is irradiated.

36. A method of processing a cooling drum for metal cast strip by continuous casting according to claim 34, characterized in that: the surface layer of the cooling drum before said laser light is irradiated has a smooth curved face.

37. A method of processing a cooling drum for metal cast strip by continuous casting according to claim 35 or 36, characterized by forming a plated layer consisting of any one or the combination of Ni, Ni-Co, Ni-Co-W, Ni-Fe, Ni-W, Co, Ni-Al and Cr on the surface of said cooling drum either before or after the irradiation of said laser light.

38. An apparatus for processing a cooling drum for metal cast strip by continuous casting characterized by:

being provided with; a drum rotating device which rotates a cooling drum for thin slab continuous casting at a prescribed constant rate, a Q-switched CO_2 laser oscillator which outputs light having pulse energy of 50 to 150 mJ and total time span of 30 to 50 μsec at the pulse repetition frequency of 6 kHz, a laser beam scanning apparatus which scans said cooling drum in the direction of the rotation axis with a laser beam output from said oscillator, a condenser which condenses the laser beam into a diameter of 50 to 150 μm, and a copying controller which measures the crown of said cooling drum on-line and, based on the signals, controls the spacing between said condenser and the surface of the cooling drum to a constant distance: and forming fine holes having a prescribed diameter and depth at a constant interval all over the surface of said cooling drum.

39. A method of forming holes on a metallic material with laser light, wherein holes are formed by coating one of oils and fats as a coating material on the to-be-processed surface of said metallic material before the holes are formed on the metallic material with a laser beam and then irradiating pulsed laser light, characterized by using a coating material having the absorption coefficient of not more than 10 mm^{-1} at the irradiated laser wavelength and determining the thickness of the coating material so that the transmittance of the laser light by the coated layer is not less than 50 %.

40. A method of forming holes on a metallic material with laser light according to claim 39, characterized in that said metallic material is a plated layer which covers the peripheral surface of a cooling drum for thin slab continuous casting.

41. A method of continuously casting a metal cast strip characterized by: pouring molten steel onto the peripheral surfaces of cooling drum for thin slab continuous casting, which rotates in one direction,

according to any one of claims 1 to 12 and 20 to 30, cooling and solidifying said molten steel on the peripheral surfaces of said cooling drums, and continuously casting a thin slab.

42. A method of continuously casting a metal cast strip characterized by: forming a molten steel pool on the peripheral surfaces of a pair of cooling drums for thin slab continuous casting, which are disposed parallel with each other and which rotate in the opposite directions, according to any one of claims 1 to 12 and 20 to 30, cooling and solidifying said molten steel poured into said pool on the peripheral surfaces of said cooling drums, and continuously casting a thin slab.

43. A method of continuously casting a metal cast strip characterized by: forming a molten steel pool on the peripheral surfaces of a pair of cooling drums, which are disposed parallel with each other and which rotate in the opposite directions, according to any one of claims 13 to 17, covering said molten steel pool with an atmosphere of non-oxidizing gas soluble in the molten steel or the mixture of non-oxidizing gas soluble in the molten steel and non-oxidizing gas insoluble in the molten steel, cooling and solidifying said molten steel poured into said pool on the peripheral surfaces of said cooling drums, and continuously casting a thin slab.

44. A method of continuously casting a metal cast strip characterized by: forming a molten steel pool on the peripheral surfaces of a pair of cooling drums for thin slab continuous casting, which are disposed parallel with each other and which rotate in the opposite directions, according to claim 18 or 19, covering said molten steel pool with an atmosphere of non-oxidizing gas soluble in the molten steel or the mixture of non-oxidizing gas soluble in the molten steel and non-oxidizing gas insoluble in the molten steel, cooling and solidifying said molten steel poured into said pool on the peripheral surfaces of said cooling drums, and

continuously casting a thin slab.

45. A method of continuously casting a metal cast strip characterized by: forming a molten steel pool on the peripheral surfaces of a pair of cooling drums for thin slab continuous casting, which are disposed parallel with each other and which rotate in the opposite directions, according to any one of claims 31 to 33, cooling and solidifying said molten steel poured into said pool on the peripheral surfaces of said cooling drums, and continuously casting a thin slab.

46. A method of continuously casting a metal cast strip according to claim 45, characterized by forming fine holes, by processing, while said cooling drums do not contact molten steel.

47. A thin slab which is produced by continuously casting molten steel using cooling drums for metal cast strip by continuous casting according to any one of claims 1 to 33, characterized in that: molten steel commences its solidification with solidification nuclei generated at the portions of molten steel contacting the rims of the dimples on the peripheral surfaces of said cooling drums as starting points, and then solidifies with solidification nuclei generated at the portions of molten steel contacting the fine humps, fine holes or fine unevenness on the surfaces of said dimples as starting points.

48. A thin slab according to claim 47, characterized in that the starting points of solidification nuclei generated at the portions of molten steel contacting the rims of said dimples are formed in the shape of the circle 0.5 to 3 mm in diameter of circle equivalent.

49. A thin slab according to claim 47 or 48, characterized in that the starting points of solidification nuclei generated at the portions of molten steel contacting said fine humps, fine holes or fine unevenness are formed at the interval of 250 μm or less.

50. A thin slab which is produced by continuously casting molten steel using cooling drums for metal cast strip by continuous casting according to any one of claims 1 to 33, characterized in that: reticular connected depressions formed by the contact of molten steel with the rims of the dimples on the peripheral surfaces of said cooling drums and the consequent solidification of the molten steel exist on the surfaces of the thin slab; and fine depressions and/or fine humps exist in each of the regions partitioned by said reticular connected depressions.

51. A thin slab according to claim 50, characterized in that each of the regions partitioned by said reticular connected depressions is a region 0.5 to 3 mm in diameter of circle equivalent.

52. A thin slab according to claim 50 or 51, characterized in that fine depressions and/or fine humps exist at the interval of 250 μm or less in each of the regions partitioned by said reticular connected depressions.

53. A thin slab according to any one of claims 50 to 52, characterized in that fine depressions and/or fine humps exist at the bottom of said reticular connected depressions.

54. A thin slab which is produced by continuously casting molten steel using cooling drums for metal cast strip by continuous casting according to any one of claims 1 to 33, characterized in that: molten steel commences its solidification with solidification nuclei generated along the reticular connected depressions formed at the portions of molten steel contacting the rims of the dimples on the peripheral surfaces of said cooling drums as starting points and with the shape of said reticular connected depressions being maintained, and then solidifies with solidification nuclei generated at the portions of molten steel contacting the fine humps, fine holes or fine unevenness on the indented

surfaces of said dimples as starting points.

55. A thin slab according to claim 54, characterized in that each of the regions partitioned by said reticular connected depressions is a region 0.5 to 3 mm in diameter of circle equivalent.

56. A thin slab according to claim 54 or 55, characterized in that the starting points of solidification nuclei generated at the portions of molten steel contacting said fine humps, fine holes or fine unevenness are formed at the interval of 250 μm or less.